Integrating Systems Engineering Concepts into Transportation Research, Education, and Practice

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Systems Engineering: a definition and some concepts

- **Systems Engineering**/an interdisciplinary process that ensures that the customer's needs are satisfied throughout a system's entire life cycle.

- Define the Problem/identifying customers/stakeholders, understanding customer needs, defining system requirements and system functions.

- Articulate Objectives/determining what will be achieved

- Formulate and Evaluate Alternatives/develop concept of operations plan, architecture and model system

- Integrate requires extensive wire and wireless communication, interfaces, and coordination.

- Deploy the system/means implementing the system, producing outputs, outcomes (+ and - ?)

- Assess performance and re-evaluate/ employ quantitative/qualitative measures
Regional Traveler Information Center (RTIC)

- Transportation research, educational, and deployment initiative at the University of Massachusetts Amherst serving the 5 College Area (UMass, Amherst College, Hampshire College, and Mount Holyoke College, and Smith College)

- Collaborative venture including Umass Transportation Center, UMass Transit Services, U.S. DOT, and MassDOT
RTIC as a Research and Teaching Laboratory

- ITS field lab for University Transportation Studies
  - Source of traffic data
  - Real-life ITS experience
  - Research opportunities
  - New technologies
RTIC’s Objectives

- Establish Transportation Database
  - Collection
  - Analysis
  - Dissemination
- Provide Highway Travel Advisories
  - Construction
  - Road closures
- Provide Public Transit Advisories
- Support academic activities

Traffic camera and license plate reader system
The diagram depicts the basic communication channels between the subsystems.

The subsystem diagram is a top-level architecture interconnect diagram.

Variations of the subsystem diagram are sometimes used to depict regional ITS architectures or project ITS architectures at a high level.
Roadside to RTIC

RTIC Database

Roadside Sensor

Internet
Center to Center

RTIC Database

Internet

Other Data Center

Sensors
Traffic Cameras

- Network enabled cameras
  - Dial up
  - Ethernet
  - Wireless
- Most popular RTIC resource
License Plate Recognition Challenges

- Privacy!!!
- Illumination
- Computationally expensive
- Massachusetts plates
- Occlusion
- Bumper stickers
Travel Time Estimation

- License plate reader
- Electronic toll collection tags
License Plate Recognition Challenges

- $$$
- Privacy
- Illumination
- Computationally expensive
- Massachusetts plates
- Occlusion
- Bumper stickers
Travel Time Estimation Using FASTLANE Tags

- Tag is programmed with station number and timestamp at each reader station.
- System calculates travel time between previous and current station.

Travel time of 25 minutes from Station 1 to Station 2

No personal or uniquely identifiable information collected!

<table>
<thead>
<tr>
<th>Station 1</th>
<th>Station 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>read</strong></td>
<td><strong>written</strong></td>
</tr>
<tr>
<td>Station</td>
<td>?</td>
</tr>
<tr>
<td>Time</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>read</strong></td>
<td><strong>written</strong></td>
</tr>
<tr>
<td>Station</td>
<td>1</td>
</tr>
<tr>
<td>Time</td>
<td>12:00</td>
</tr>
</tbody>
</table>
FastLane Travel Time Estimation

- Route 116 launched September 1st, 2007
- Route 9 launched September 1st, 2009
- 24,209,957 tags
- 3,822,659 journeys
Installation

Regional Traveler Information Center
Travel Time Data

Travel Times for 11/6/2007
Northbound
Travel Time Data with Congestion

North Bound Travel Time
December 13, 2007

Snow storm beginning at approximately 11:30
I-91 Bluetooth Travel Time Estimation

- Similar process to LPR and Toll-Tag
- System detects **discoverable** Bluetooth devices
- **MAC addresses** matching
- Many vehicles carry such probes
  - Phones
  - Computers
  - GPS
  - Hands-free devices
  - Stereos
  - Toys
  - ...

![Image of Bluetooth devices and travel time estimation system]
I-91 Travel Time Study

- Comparing different methods of collecting travel times on a rural highway.

- Commercial data
  - INRIX – Fleet GPS
  - TraffiCast – Bluetooth

- Supporting data
  - Video based license plate matching
  - Floating car
    - GPS
    - License plate
Results of statistical tests for Bluetooth and GPS on different segments.

For a travel time of 7 minutes, an error of 5.5% represents 23.1 seconds.

How does this error affect our decisions?
Sources


- IEEE Intelligent Transportation Systems Society Newsletter
  IEEE ITS Society Newsletter Vol. 16, No. 1, January 2014

- USDOT Joint Program Office, ITS Program
Closing comments/Questions??

- Transit Management and Operations Certificate Program (Uass Transit, UMTC, FTA, and First Transit, Inc)

- masstraveler.com  RTIC website

- collura@ecs.umass.edu
Bus Tracker

- GPS/computer/cell modem
- Originally a Computer Science DARPA research project
- Data onto a Google Map
  - Bus passengers
  - Dispatchers
- End of life 😞
- New PVTA AVL
DieselNet/RTIC Topology
Bus Tracker Travel Time Algorithm (single vehicle)

travel time = selected end point time - selected start point time